BACK STRAINS IN BRICKMAKING

By F. S. Crawford, E. J. Podgorski, E. W. Felegy,
Steve Star, Roy G. Stott, and L. A. Van Fleet

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INTRODUCTION

This study was made to find methods of preventing back strains among workers in brick plants, however, the information should apply to other industries that employ hand labor to process materials. The report is based on information in letters from Bureau of Mines engineers and other safety men in the United States who visited numerous brick plants.

Back strains, as well as hernias and other muscular strains, result when certain body structures are subjected to strains greater than they can withstand. Such breakdowns may be prevented simply by not straining these body structures. This is simple in theory but complicated in practice. It requires primary education of new workers and reeducation of older workers in the best method of lifting, preemployment physical examinations to select employees for the jobs that require constant lifting, all possible mechanization of material-handling operations, relocation of machinery, and elevation of working surfaces to reduce to a minimum the muscular effort the workers must exert to perform operations impossible to mechanize. Accidents of any kind are a total loss for the American economy and decrease productivity; whereas mechanization raises the level of productivity and constitutes progress toward total safety. Heavy lifting should be done mechanically whenever possible, saving the men to direct the machines. This is an essential step in preventing strain accidents.

Lifting strains are common in industries using hand labor to process the product. Such strains probably result in more suffering, loss of time and wages, and disability than almost any other type of injury. Yet, of all industrial injuries, they should be the easiest to prevent by mechanization and education. With the increasing cost of labor, many innovations are being developed to eliminate manual handling of material. While this is very encouraging, strains, sprains, and hernias still rank high among accident-claim losses.

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CLAY-CONSTRUCTION-PRODUCTS INDUSTRY

The clay-construction-products industry requires a large amount of hand labor. The injury-frequency rate in this industry in 1949 was an average of 36.8 disabling work injuries in each million employee-hours worked. This was higher than for any other industry in the stone, clay, and glass group and more than double the all-manufacturing average of 15.0. Only 5 of the 145 listed manufacturing industries had injury-frequency rates higher than that of the clay-construction products industry.1/ This Bureau of Labor Statistics study showed that nearly 30 percent of the temporary total disabilities were strains and sprains and that about half of these were back cases. Most of the remainder were ankle, leg, wrist, and shoulder sprains, reflecting the large volume of manual material handling prevalent in the industry and the irregular working surfaces common in these plants. The commonest variety of injuries arises, not from physical contact with some particular object or substance, but from bodily motions or misuse of the body; four-fifths of the accidents in this group were simple cases of overexertion, primarily in lifting, carrying, and pushing objects. Manual material handling, therefore, as shown in this study, is indicated as this industry's chief source of injuries.

STRAINS IN BRICKMAKING

Bricks are made by the dry-press and the stiff-mud processes. In the dry-press process the clay has a low moisture content and is pressed into brick and delivered to the "off-bearer" on the press table. The off-bearer picks up the freshly pressed bricks and places them on a drier car or a pallet for transportation. In the stiff-mud process the dry clay is mixed with water in a pug mill and extruded through a die to a roller conveyor, where it is cut into bricks with a wire cutter. These bricks are carried by conveyor to the off-bearer, who picks them off the conveyor by hand and places them on the car or pallet. The job of off-bearing the freshly cut bricks is strenuous and has not been mechanized successfully. While the weight of each brick is comparatively small, the off-bearer must perform the same motion repeatedly, as the bricks are delivered on the press table or the conveyor. If this motion

1/ Bureau of Labor Statistics, U. S. Department of Labor, Injuries and Accident Causes in the Manufacture of Clay Construction Products: Bull. 1023, 1951.

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is extreme and leaves him slightly off balance while twisting the upper part of the body, the off-bearer may strain certain muscles or even tendons, particularly if his body is not adapted to the extreme motion. He may even set up strains in some joints, such as the sacroiliac or the ankles.

In the job of off-bearing the fresh bricks from the conveyor or brick press, the operator must pick them up and turn his body with the bricks in his hands, and then lay them down carefully in another place in an orderly pile, which will then be transported mechanically to another stage of the brickmaking process. This manual process is responsible for most of the sacroiliac strains in the brickmaking industry. The constant twisting motion combined with poor adjustment of working surfaces and insecure footing may subject the operator to strains, injuring the back. Such injuries might be prevented by careful medical and physical selection of employees best-suited to this class of work, rearrangement of working surfaces and footing, and education of employees in the safe methods of lifting.

The plant management can arrange the height and position of working surfaces, and positions of delivery of materials in process in order to reduce to a minimum the strain on the workman, who in turn can learn to use his body so as to avoid the extreme motions that bring on the strains. The workman must use his own mind to direct his muscles to do the job of handling or lifting in the right way. Some men must be trained in new, improved methods of lifting to replace old bad habits.

When a man must lift heavy or bulky materials, he usually can get help if he needs it; however, if he must lift by himself, he should learn to use his strong leg and thigh muscles and arms to avoid strain on his back. He should crouch to the job with feet slightly apart and knees bent, making sure of good footing and a good grip and lift with his back as nearly vertical as possible, by straightening out the legs. Many men lift with the back and arm muscles alone, not taking full advantage of the much larger leg and thigh muscles. When they try the leg-lift method they are surprised to learn how much easier it is.

When it becomes necessary, in the process of manufacture, for a man to pick up a brick from one location, rotate the body with this load and lay it down in another place, there is a twisting motion of the spine on the sacrum, the central bone in the pelvis. This twisting, when kept up for a long time, may cause a strain in the sacroiliac region. The strain becomes more pronounced when the motion is extreme and the man is partly off balance. If the workman will lift his feet when turning his body so that he keeps his feet under him, there will be less strain on the sacroiliac, knee, and ankle joints because there is less twisting. He will do the job with less effort and is more likely to avoid injury to his back.

TRAINING MEN IN PREVENTION OF STRAINS

Some insurance companies give considerable attention to the problems of accident prevention. At a recent safety conference attended by representatives of the mining companies in the Lake Superior Region, James E. Kavanaugh

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presented a paper on Strain Prevention[8/] from the standpoint of the individual. This paper points out that an individual develops both good and bad habits by his actions over a period of time and that a safe worker is one who has trained his mind to be constantly on the alert for obstacles and is always ready to change his decisions accordingly. He is known as the man who "thinks defensively," his attitude is good, and he is a "safety conscious" individual. In order to train new men in good work practices, Kavanaugh suggests the following points for guidance in instruction and training:

1. When starting a task involving lifting or other muscle effort, always be sure it can be done safely. This may require a test of its weight, clearing the way, and other points in planning the job.

2. Be defensive in your thinking. Leave a margin of safety. In case of doubt as to whether the job can be done, decide in favor of your body safety, and get help.

3. Use the mechanical arrangement of the body to best advantage. The back muscles are ordinarily the weak link in the system. Training and instruction should emphasize lifting with the back as nearly vertical as possible, and applying the necessary lifting force with the strong leg and arm muscles which were given to us for that purpose.

4. Emphasize thinking ahead defensively. Man's reaction, when emergency develops, will depend on how clearly he has considered possible emergency. When it comes to a choice between the load and the body, the decision should be in favor of the body for the load can be replaced.

5. Emphasize the fact that careful planning and maintaining a good margin of safety will forestall emergency conditions and save both strains on body muscles and damage to the load being handled.

6. As an instructor, hold up to those with whom you are associated a clear and unquestionable attitude of defensive thinking in all work. When it comes to training a man in matters of thinking and acting, there is no more forceful method than that of good example. The reverse is also true. No matter how comprehensive and good your training may be, all can be undone if you, in your work, set a poor example.

To correct and retrain men who have acquired bad work practices, Kavanaugh suggests that the manner of handling be patterned after the program used so successfully by many in handling the problem of developing safe drivers of motor vehicles.

1. The potential instructor must identify the problem to be dealt with specifically. This problem must be thoroughly analyzed and studied in order that the proper corrective action can be planned.

8/ Kavanaugh, James E. (Travelers Insurance Co.), Strain Prevention: Presented at 28th Annual Conference of the Lake Superior Mine Safety Council at Duluth, Minn., May 23, 1952, pub. in Proceedings of Conference.

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2. The problem must be established in the mind of the man in question. This is accomplished by intelligent discussion of the problem, demonstration, and through example.

3. The man to be corrected must decide to change his ways. This is the selling job. There would probably be a lot more Model T Fords on the road today if the automobile salesman did not take the initiative in selling the new models. This same method of attack is effective in selling new ideas.

4. The instruction and training must be given in such a way as to point good reason for every change in habit and attitude. This requires real leaders of men as instructors who are well informed and who have studied the problem to such a point that they are able to offer convincing reasons as to the desirability of making a change, either in performed mental decisions or in work habits.

5. The instruction and training should be complete, including the reminders, day after day, necessary to keep the new method of action in effect until the right habit has been fully established for the rest of the man's life.

6. The principles established for training new workers must be used in evaluating the effectiveness of the instruction. Failure to achieve these results can indicate only that more work is needed. The job will never be done until your efforts are really effective.

It is interesting to note the reaction of foremen to the need for safety training in clay-products plants in year-end safety meetings. At several such meetings the foremen were asked to comment on their plans for the following year to reduce hazards in their own sections.

The foremen of a tile-press room planned to conduct a consistent program of job instruction for all employees in the department to teach them not only how to do a safer job but a better job. He expected the program of safety inspection and job instruction to reduce accidents and to be reflected in a more orderly process of production and handling of materials.

The foreman of a tile-packing department stated that there was a serious need throughout the department for employee job-instruction training.

The superintendent stated that he expected all supervisors consistently to teach employees safe work habits, and to consider prevention of accidents their greatest individual responsibility.

One foreman of a sewer-pipe department expected to devote more time to teaching safer work habits to employees. Another sewer-pipe department foreman stressed the need for constant follow-up by supervisors to see that job instruction and safety rules were followed by their employees.

Another foreman believed that all foremen should receive more safety training themselves, so they could do a better job of teaching safe work habits to employees.

Still another foreman stated the need for further training of supervisors in safety, and suggested that part of their foremen's safety meetings be devoted to teaching the supervisors more of the fundamentals of job-safety instruction.

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The superintendent recognized the general need for further education and training for both supervisors and employees and suggested that the first item on the program should be to give intensive training to all drivers of power mobile equipment; this would be followed throughout the year with additional education and training activities for both supervisors and employees. He emphasized the necessity for keeping safety in the minds of all employees.

PREEMPLOYMENT PHYSICAL EXAMINATIONS

Strains can be avoided to some extent if the company physician can select prospective employees for certain jobs through preplacement physical examinations to determine their physical capacity to handle such jobs. The job of off-bearing brick, or any of the other jobs where constant handling of weights is involved, is included foremost among jobs where men could best be selected by preplacement physical examinations.

MECHANIZATION OF MATERIAL HANDLING

One of the best mechanical improvements for handling materials is the versatile fork-lift truck, which has been adapted in many ways. The usual method of handling bricks with the fork lift is to pile them on pallets, which are lifted by the forks of the truck, transported, and then elevated to storage piles. This truck is rapidly replacing wheelbarrows for transporting bricks. The forks on some of the trucks have been changed so that they expand, and these expanding forks are used to grip bricks laid out in a pattern such that the bricks are held between the forks. These bricks constitute a platform on which the rest of the pile of bricks is laid, eliminating the need for a separate pallet on which to pile and transport bricks. Use of the expanding fork will also eliminate much handling of the bricks. The bricks can be laid by the off-bearers in the prescribed pattern and from then on throughout the plant to the storage yard the pattern could remain intact. Expanding forks would be used to pick up a pattern of bricks and set it on a drier car; when dried the expanding fork would transfer the load to the tunnel-kiln car of to the pile in the periodic kiln. It could be used to unload the burned bricks and transport them to storage piles and from there to delivery trucks or railroad cars. Since there is always some breakage, however, and since it is necessary to inspect and sort finished bricks, there will still be some rehandling of the burned bricks.

RELOCATION OF MACHINES AND WORKING SURFACES

Sometimes the brick-raking machine or point of off-bearing from a belt may be placed too far from the track carrying the drier car, or the turn a man must make in order to pick up, transport, and lay down the brick may be excessive. Perhaps the floor on which a man works is irregular and the distance from the off-bearing surface to the floor and from floor to the first layer of the pile of bricks is not a comfortable height. This can be regulated by raising or lowering the base on which a man stands. A study can be made as a guide to developing floor plans so as to relocate machinery to the best advantage to the workman.

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In response to requests for data from various brick plants regarding the measures they have taken to reduce the occurrence of strains, a number of replies were received. All of them contribute some information of value.

Plant 1

This company teaches employees how to lift properly, with the least amount of strain on the back. They have found that, when an employee must pick up materials and turn more than 30° before setting the load down, he must pick up his feet and turn his feet along with his body. They have also found it necessary for an employee to maintain a good balance with his feet well-placed and solid underneath him, because, when a person loses his balance, or is even only slightly off-balance while carrying a load, muscular ligament strains inevitably result. Acting on the basis of these observations, they develop floor plans and mechanical placement so that the work can be performed within the human tolerances they have decided upon as being within a safe limit. In many cases, they have found it possible to raise or lower the base on which an employee stands to perform his work; raise or lower the machine from which he picks up materials; and raise or lower the base on which he sets down the materials. In some instances it was a combination of adjusting all the positions. They also found it possible in most cases to adjust distances between the point of pick-up and set-down of the weight and not only reduce the degree the employee had to turn but reduce it to a point that he could at all time keep his feet well-placed underneath him and retain a good, solid back-balance.

Early in the effort of this company to reduce strains from lifting, they recognized that many people have congenital back defects and especially defective back structures. They established a preemployment program that includes a physical examination of an applicant that is based on the job that he would be expected to perform. With intelligent placement of the employee on a job according to his physical ability to perform that job, they found over a period of years, through actual experience, that a number of widespread practices and beliefs regarding prevention of lifting strains are inconsistent with the results of experience.

Back braces or reinforcement belts have been popular in many areas and even among many competent medical men to relieve back strain and to support weak backs. A close study of these measures in the clay-products industry by this company has not proved such methods to be sound or effective. Its medical department has found that, at the very best, a back belt may offer a person with a sore back some reinforcement and protection to the back so far as bending forward or backward is concerned, and while he has acute sprain symptoms; however, such a belt offers no protection to the back for a turning or twisting movement, and the great majority of back strains show in their statistics to result from turning and bending. They have also found that when a belt is worn for some time, the back muscles begin to atrophy, because the back belt is performing the function the muscles ordinarily perform; consequently, the patient develops a weak back and frequently must wear the back belt permanently. Consequently, this company rarely uses a back belt and then seldom more than a

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week or 10 days. After this, extensive exercises are given to the patient to insure restoration of proper muscular function of the back.

Plant 2

A report from a plant manufacturing refractory bricks stated that it had experienced few accidents from handling bricks that resulted in back strains. This plant uses conventional mechanized handling operations for heavy loads, but individual bricks are handled by hand while loading and unloading. It believes that the type of labor it employs might have some influence on its good safety record. New laborers are trained by experienced workmen rather than by the foremen. Ramps, travelways, and aisles are 42 inches minimum width and uncluttered and no steep grades are necessary for handling hand trucks, wheelbarrows, and fork-lift trucks. Good footing is assured by sloping docks (for drainage), roughened trowel concrete finish, and the gritty nature of the spillage. Loading docks are provided for both railroad and truck loading. It was noted that employee morale at this plant was very good. The plant had excellent working conditions, a change house with bathing facilities, and outstanding supervision.

Plant 3

At this plant every half hour a relief man relieves one of the two men who unload the newly cut bricks, which pass onto a belt line from the auger and cutting machine. This conserves the strength of the men and lessens possibility of fatigue. Unloading the kilns at this plant was said to be the most strenuous job and most likely to cause back strains. The men unload the beehive kilns by hand onto a rubber-tired, platform-type wheelbarrow. A total of 140 bricks, weighing about 720 pounds, is loaded onto the wheelbarrow. Good balancing and strength are necessary to maneuver this load, therefore, an inexperienced man is not put on a job such as this. Inexperienced men are first put in the yard, where they become accustomed to handling the wheelbarrow, and after the proper experience the new men can transfer to the kilns. These men, both experienced and inexperienced, work under supervision.

Loading trucks with bricks for delivery to building or construction jobs is an interesting procedure at this plant. Wooden pallets are loaded by hand or with magnesium or steel tongs, the magnesium type being preferred owing to their lightness and ease in handling. The tongs work on a leverage and clamping action with adjustment slots for the movable clamp, making it possible to lift one to eight bricks at a time. Normally, seven is the limit. One man can load 15 to 20 thousand bricks a day.

After a pallet is loaded with 1,600 to 2,500 bricks, a specially equipped truck places a steel frame or box vertically against the bricks on the pallet. This frame or box is a four-sided receptacle resembling the bed of a pick-up truck without the tailgate. Two rods are placed under the pallet and held in place by hook attachments on the steel box. The truck has attachments that hook onto the steel box, and a truck-hoisting device lifts the steel box containing the pallet and bricks and places it horizontally on the transporting truck. During hoisting, however, the steel box is vertical, and the rods act as a base to hold the pallets and bricks in place. This is called the

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Fontaine system of packing. The trucks are unloaded in the same manner, and the steel boxes are brought back to the plant. The pallets are brought back after the job is completed.

All men at this plant are instructed to lift properly, and all heavy lifting is done mechanically, using such equipment as fork-lift trucks. No back strains have been reported at this plant.

Plant 4

In this plant clay is mixed in a pug mill, extruded in the form of a bar, cut up into bricks by a wire cutter, and then moved onto a belt line. At this point the bricks are handled first. One man, called a flipper, spaces bricks in pairs, and three other men take the bricks from the belt line and place them on drier cars. Drier cars are pushed to the drier manually. After 2 days in the drier, the dry bricks are picked up and placed on the kiln cars by hand. These kiln cars are moved into and out of the tunnel-kilns mechanically. After burning, the bricks are picked up by hand again and placed on pallets. The pallet loads of brick are transported to the yard by fork-lift trucks.

Railroad cars and trucks are loaded by hand. The pallets loaded with bricks are placed on the car and trucks with fork-lift trucks. Then the bricks are placed in proper order in the railroad cars or trucks for shipment to market. A convenient piece of equipment used in loading the railroad cars and trucks is the tongs. By a clamping effect and leverage action, seven bricks can be lifted at a time when the handle of the tongs is lifted. During the past 4 years there have been no strains and only minor injuries at this plant. All work is supervised, and no heavy lifting is done by hand.

Plant 5

This plant uses a number of Boyd refractory brick presses, which press four bricks on each stroke. The operators pick up one brick in each hand and set them on a drier car, which is directly in front of the press, two operators working on each press. The operators stand between the drier car and the press, with one side to the press and the other side to the drier car. To pick up the brick from the press-table and set it on the drier car involves a turning or twisting motion of about 130°. The bricks are delivered from the press on a table 34 inches above floor level. The bottom of the drier car is 14 inches above the floor, and the dryer cars are loaded from this elevation to about 4 feet above the floor. The bricks average about 8 pounds each, and each operator normally handles about 9,500 in each 8-hour shift.

Plant 6

This is a silica-brick manufacturing plant using Boyd brick presses. The bricks are pushed off the press automatically onto a light, short metal pallet, each pallet holding four bricks. Two operators work at each press as a team. One man picks up a pallet of four bricks from the press table, about 32 inches above the floor, turns on a 90° angle, and sets the pallet of bricks on a drier car, which is at one side of the press. While the first operator is

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performing this motion, the next operator takes the next pallet of pressed brick, turns to a 90° angle, and sets the pallet of bricks on a drier car at the opposite side of the press. Thus each operator picks up and handles alternating pallets of brick. Each brick weighs approximately 15 pounds, and each operator handles about 9,000 bricks in an 8-hour shift.

In pressing clay refractory brick with Boyd presses two operators work on each press, pressing four bricks at a time. Each operator picks up two bricks, one in each hand, from the off-bearing table, about 34 inches above the floor, and takes two to four steps to set the bricks on tunnel-kiln cars. In this operation the top of the tunnel-kiln car is exactly level with the floor. These operators experience a rather extreme bending motion when they stand the first tier of bricks on each car. The bricks are loaded about 4 feet above the top of the car. This operator makes a rather extreme turn from the time he picks up the bricks from the press table, making an approximate 160° turn by the time he sets the bricks on the tunnel-kiln car. The average weight of each brick is 9 pounds. In all of these operations this plant has not had a back strain of any kind reported during the past 5 years. The operators believe the chief reasons they do not suffer back strains, especially the sacroiliac type, is that they carefully select employees for these jobs and they all undergo a rigid preemployment examination to determine their physical ability to do that work. Then each new operator is thoroughly trained to pick up and handle the bricks in a manner affording him the most comfortable body motion. The company has very little turn-over in these jobs, most of the personnel having been on that type of work for a number of years.

Plant 7

This is a face-brick manufacturing operation, where employees pick the brick off the conveyor belt and set them on drier cars. The face bricks are delivered on the conveyor belt in clusters of four, weighing about 28 pounds per cluster. The off-bearer picks up a cluster of these bricks at a time, using both hands to pick up the four bricks as a unit. The conveyor belt is about 18 inches above the floor level, and the bottom of the drier car is approximately 14 inches above floor level. The off-bearers usually stand the lower tier on the car in a somewhat bent-over position, swinging torsos and shoulders in a side-to-side motion, picking the bricks off the conveyor belt and putting them on the car without changing the position of the feet. In this operation they use their hips as a pivot for the upper part of the body to bend on. After the drier cars are loaded to the second deck, the off-bearers stnd up straight, bend over, pick up the bricks from the conveyor belt and straighten up as they turn about 135° to set the bricks down on the drier car. This operation is performed by a four-man crew on each machine. Two of the men off-bear the bricks from the conveyor belt to a drier car; one man operates the pug mill, and the fourth man transfers cars. They alternate from one job to the other at 30-minute intervals. Each of them will off-bear approximately 35,000 bricks per 8-hour day. The company has considerable turn-over in this type of work. A new employee who is not used to such work will have considerable difficulty during the first 2 to 4 weeks, until he has become hardened to it. During the past 5 years this plant had one case on record where an employee who had been on this job about 2 months experienced a sacroiliac strain, which was treated by the company doctor for 2 weeks. The employee was not disabled but was confined to light-duty work during the

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treatment. Occasionally a man on this job experiences a slight soreness in the back, which usually clears up within a day or two and is not enough to necessitate a change in his job during medical treatment, or even a slow-down in his work output.

Plant 8

This plant manufactures a variety of clay products. There are many machinery hazards, including crushers, mixers, power presses, industrial trucks, stationary and portable grinders, extensive furnaces or kilns, and power transmission equipment involving hand lifting and handling materials. In hand handling, many employees perform a continuous operation of bending forward, picking up objects weighing 5 to 12 pounds, straightening up, turning, and setting the objects down again. The materials are picked up and set down from varying heights, which may be in a position near the floor, near shoulder height, or any point in between. The turning range may vary from 45° to more than 190°. The distance between the point of pick-up and set-down may vary from 36 inches to 8 feet. An employee handling materials may, in the course of an 8-hour day, individually handle a maximum amount of material approaching 70 tons.

This company has other material-handling operations where employees handle lighter weights, picking up the weights from approximately waist height to shoulder height, with the objects ranging from a few ounces to 2 pounds each. The materials are picked up quite rapidly and with a total arm load of approximately 20 to 25 pounds. The employee turns and sets the armload of materials down at heights from knee- to waist-high. These are constantly repeated motions and involve the handling by one employee of a maximum of 7,000 to 8,000 pieces of material during an 8-hour day.

In other operations employees pick up heavy materials weighing 40 pounds to a maximum of 220 pounds each. This is one of their most difficult operations from several standpoints - it is an operation where a set method cannot be developed, or alterations made in the method of picking up, the distances traveled, or the method of setting down the burden. Often the heaviest weights must be picked up from an exceedingly awkward position. It also is frequently necessary to set down the heaviest weights while the employee is in an extremely awkward position - that is, partly bending over and with the body in a twisted position.

Plant 9

In this plant raw clay is loaded by power-shovel into trucks and transported to the storage shed. A dragline in the shed moves the clay into a hopper from where it is fed by gravity onto a conveyor belt that feeds the pulverizer. The pulverizer discharge is lifted by a bucket elevator to a silo, and a second belt conveyor transports the pulverized clay to the pug mill to be mixed with water. The pug-mill product is extruded on a belt passing through a wire cutter, and the freshly cut brick is transferred by hand from the belt to small hand trucks.

The hand trucks are pushed onto a transfer or dolly and from the dolly into drying kilns. A cable from the discharge end of each kiln passes through

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the kiln under the trucks and is attached to the rear of the truck entering the kiln. Trucks are bumper-to-bumper through the length of the kiln, and each truck remains in the kiln about 2 days. When a truckload of dried bricks is removed from the front of the kiln, another truckload of wet bricks is added at the rear of the kiln. The trucks of dried brick are pushed by hand to periodic burning kilns. All track grades are small and favor the load from the wire cutter to the burning kilns. Empty trucks are pushed up grade when returned from the burning kilns to the wire cutter. Dried brick is unloaded by hand from the hand trucks and stacked by hand in the periodic kilns, each of which has a capacity of 51,000 bricks. The bricks burn for 7 days, reaching a maximum temperature of about 2,050° F. Colored bricks are obtained by "flashing" with metallic salts in the kiln. Finished bricks are loaded by hand into standard wheelbarrows of 100-brick capacity, pushed to the storage yard, and manually unloaded and stacked for storage. Bricks also are hand-loaded from stockpile into boxcars or commercial trucks for shipment. A few back strains have occurred at this plant when bricks were stacked in the periodic kilns or taken out of them.

Plant 10

This is a small plant employing only 12 men during 6 months of the year, with a maximum annual production capacity of 2,500,000 bricks. The clay is excavated by a small power-shovel loader that also transports the clay and dumps it in the pug mill, where it is comminuted, but no water is added. After the clay is molded by extrusion, it is cut by a wire cutter, and the bricks are loaded by hand on 300-brick pallets. The pallets are transported to the drying sheds by small, manually propelled, track-mounted trucks, with lifting prongs operated by lever action of the truck handle. The brick is air-dried 10 to 14 days, and the pallets are moved again by the small trucks to the burning kiln. All track grades favor the load.

Bricks are stacked by hand in an oil-fired scove kiln. Each kiln contains 400,000 bricks, which are burned 5 days. The scove kiln also is the stockpile for finished bricks, and bricks are loaded by hand from stock-pile on commercial trucks for shipment. No back strains are known to have occurred at this plant.

Plant 11

This small brick plant uses a tractor-powered hydraulic-lift fork truck to lift and haul pallet loads of brick and tile to the stock-piles and into trucks and cars for shipment. This cuts down the maximum lift a man has to make to a tong of 10 bricks or a hook holding two 6 by 12 by 12 tiles, the largest tiles they make.

Plant 12

This is a small brick plant that has abandoned wheelbarrows and now uses lift trucks and small two-prong forks to handle brick and tile. The strain and injury list has been reduced 25 percent.

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Plant 13

This small plant uses only pneumatic-tired wheelbarrows handling loads of 100 bricks, which weigh 4.2 pounds each, and 10-brick brick tongs for loading and unloading.

Plant 14

This plant makes only sewer pipe. It has lift trucks, which do a lot of heavy lifting in the yard, and has installed two belt conveyors to draw small pipe out of the kilns. Since this is an old plant, it is unable to put lift trucks on the drier floors but plans to remodel, making floors strong enough to use lift trucks so there will not be so much manual lifting and handling of products.

Plant 15

This brick plant is mechanized to the point where the management believes the number of times the separate bricks must be handled is cut almost to a minimum. While the operators believe they could go farther, they feel that this would involve a capital outlay prohibited by their volume. They have cable-conveyors to transport brick from making room to drying racks. From the drying racks the bricks are palletized and transported to the kilns by a fork-lift tractor; wheelbarrows were used before. The fork tractor has alleviated strains on the employees, not only by replacing wheelbarrows, but because they can raise the equivalent of three wheelbarrowloads of bricks about 8 feet high in the kiln. The bricks are set about 12 feet high in the kilns; before they had to be pitched from the ground to the brick setters, who stood approximately 7 feet above the ground, so strenuous pitching is no longer necessary.

This plant has also been equipped with a front-end loader tractor, which has dispensed with all the strenuous coal shoveling. This tractor has proved to be an employee saver in many ways, doing away with hand shoveling of sand and clay and cleaning up the culls.

The company has considered the possibility of developing a machine to handle the individual bricks but finds that this appears almost, if not absolutely, impossible, since it would have to be of such an intricate nature that it would not be feasible. The main point in cutting down injuries is to reduce the number of times the individual bricks must be handled in production. This will be done increasingly as the cost of labor rises and the cost of mechanization decreases.

Plant 16

This plant uses brick hooks to handle the separate bricks while pallets and wheelbarrows are being loaded and unloaded. This method helps to reduce back strains. However, if the bricks are flat set in the kilns, it is not possible to use the brick hook.

The men that handle or push wheelbarrows in hauling bricks are instructed to bend their knees when first gripping the wheelbarrow handles and as they

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raise their load to wheel or walking positions, the load is raised (or handles of wheelbarrow) by using the leg muscles and not the back; this eliminates back strains.

It is also important to adjust the location of the wheel or wheelbarrow for the height of the man. Of course, this can only be done on wheelbarrows that have the wheel mounted under the bed instead of in front as on a pan buggy. Springs were installed on the hand wheelbarrows to eliminate pulling muscles when wheel strikes bumps or hard objects.

Of course, in using materials handling equipment, the men do n not have any lifting to speak of, only the empty pallets, which are fairly light in weight.

Plant 17

The first operation in this plant is batching or mixing, where the clay is taken from storage piles in the yard, transported to a grizzly, and unloaded through the grizzly to a grinding mill. The ground material goes to a mechanical mixer or pug mill and into an extruder which delivers the clay mix in brick bar-shaped form. The bar-form clay is cut to desired brick size by a rotary cutter and transported by belt-conveyor line to the only point of manual brick handling during the entire operation. The cut bricks are placed manually directly from the conveyor belt in a prescribed pattern on drier cars. The drier car is moved by transfer car on rails to a drier tunnel and is pushed into the first drier tunnel by hand then through the last drying stages by hydraulic pusher. The entire carload of dried bricks was moved in one operation from drier car to kiln car by an electric overhead expanding-fork crane. The kiln car was then moved by transtractor - a mobile, extremely versatile industrial truck - to the transfer turntable and then to the kiln. The kiln car was moved through the direct-heat, natural-gas-fired tunnel kiln, continuous-car type, by a hydraulic pusher with a slow, steady pressure. After burning, the entire carload of finished brick was removed from the kiln car in one operation with a fork-lift truck, equipped with expanding forks, and moved to the brickyard for storage or shipping.

Loading of trucks was done by fork lift, while railroad cars were loaded by hand. The fork lift transported the brick to a loading platform at the railroad car end unloaded the brick to a hand truck which was moved manually into position for unloading by hand.

No further handling was required after the freshly cut brick was placed by hand from the off-bearing side of the belt, onto the drier car until the finished brick was ready for shipment by railroad car. Clamps or tongs for handling brick were not used in any part of the plant. A large Gerlinger lift truck was also used to pick up several patterns of brick on pallets from the storage yard and transported them to construction jobs in the area.

Interior - Bureau of Mines, Pgh., Pa.

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